Rotman - UNIST Trading Competition 2019

Case Package

Rotman School of Management
UNIVERSITY OF TORONTO

ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

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About RUTC

The Rotman-UNIST Trading Competition (RUTC) is a unique two-day event that allows teams from universities across South Korea to participate in a simulated market. Its structure is similar to the successful Rotman International Trading Competition (RITC) held annually in Toronto, where 52 schools from around the world meet and compete in simulated markets.

The competition is predominantly structured around the Rotman Interactive Trader platform, an electronic exchange that matches buyers and sellers in an order-driven market on which trading cases are run. The cases represent various scenarios for risks and opportunities and challenges participants to handle a wide range of market environments.

This case package provides an overview of the content to be presented at the Rotman-UNIST Trading Competition 2019. Each case has been specifically tailored to tackle topics in university level classes and real-life trading situations. We hope you enjoy your experience at RUTC 2019!

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Important Information

PRACTICE SERVERS

Cases will be made available on practice servers starting from July 16th. Further information on release dates can be found below and more information will be posted as it becomes available on the RUTC website. Dates and times in this case package are in Korean time unless otherwise specified.

Case Name	Release date
Algorithmic Statistical Arbitrage Case	Tuesday, July 16th by 11:59pm
Algorithmic ETF Trading Case	Tuesday, July 16th by 11:59pm
Natural Gas Trading Case	Thursday, July 18th by 11:59pm
Crude Oil Trading Case	Thursday, July 18th by 11:59pm

Practice servers will operate 24 hours a day 7 days a week until 11:00pm, Thursday, August 8th. Information on how to download and install the RIT v2.0 Client is available on the RUTC website.

The following table shows the server address and ports available for practice environments:

Case Name	Server Address	Port
Algorithmic Statistical Arbitrage Case	flserver.rotman.utoronto.ca	16600
Algorithmic ETF Trading Case Server 1	flserver.rotman.utoronto.ca	16605
Algorithmic ETF Trading Case Server 2	flserver.rotman.utoronto.ca	16610
Natural Gas Trading Case	flserver.rotman.utoronto.ca	16615
Crude Oil Trading Case	flserver.rotman.utoronto.ca	16620

To login to any server port, you can type in any username and password and it will automatically create an account if it does not exist. If you have forgotten your password, or the username appears to be taken, simply choose a new username and password to create a new account.

Multiple server ports have been provided for the Algorithmic Trading Cases to allow teams to trade in either populated or unpopulated environments. For example, if you are testing your algorithm and there are several other algorithms running, you may want to move to a different port where there is less trading.

Please note that the market dynamics in practice and in the competition cases will be the same. However, price paths will be different during the competition. In addition, market parameters during the competition may be adjusted to better account for over 80 live traders.

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Both Algorithmic Trading Cases will have new, randomized sets of security paths each time they are run on the practice server. The Crude Oil Trading Case and the Natural Gas Trading Case will have three different scenarios of news and price paths running on the practice server, which will be randomly loaded each time they are run on the practice server.

We will be running three "special" practice sessions for the cases. On July 23rd at 10:30pm, we will run a single iteration of the Crude Oil Trading Case; results will be released. On August 1st at 10:30pm and August 7th at 6pm, we will run the practice sessions for all competition cases so all teams are invited and encouraged to connect at the same time as the results will be released from each practice case. The instructions to connect to these special practice sessions will be sent via e-mail to the participants individually along with login credentials prior to the practice sessions.

ADDITIONAL SUPPORT FILES

The following support files will be provided on the RUTC website:

- The Base Algorithms for both Algorithmic Trading Cases and other relevant support will be released on July 17th.

Other documents might be posted and, if so, participants will be notified via email.

SCORING AND RANKING METHODOLOGY

The Scoring and Ranking Methodology document will be released prior to the start of the competition on the RUTC website. An announcement will be sent out to participants when the document is available.

COMPETITION SCHEDULE

This schedule is subject to change prior to the competition. Participants can check the RUTC website for the most up-to-date schedule. Each participant will also receive a personalized schedule when he/she arrives at the competition.

TEAM MEMBER ROLES

Participants must submit team member roles by **Friday, July 26th** at 11:59pm for the Crude Oil Trading Case, as there are multiple roles available. Submitted roles are considered final and substitutions following that date will not be permitted except under extreme circumstances. Further instructions on how to submit your team member roles will be sent via email. If a team misses this deadline, competition staff will randomly assign the roles.

QUESTIONS

Please send all competition-related and case-related questions on the Q&A page of the RUTC website. To ensure the fair dissemination of information, responses to your questions will be posted for all participants to see. All participants are highly encouraged to send questions on the Q&A page. For any other questions please send an email to trading@unist.ac.kr.

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Case Summaries

SOCIAL OUTCRY CASE

This is the opening event of the competition, giving participants the opportunity to make their first impression on other teams, faculty members and sponsors in this fun start to the Rotman-UNIST Trading Competition. Each participant has the opportunity to trade against each other, professors and sponsors, trying to make his/her case against them and showcasing his/her outcry skills by making fast and loud trading decisions.

ALGORITHMIC STATISTICAL ARBITRAGE CASE

The Algorithmic Statistical Arbitrage Case is designed to challenge participants' programming skills in developing algorithms using MATLAB, Excel VBA or Python to automate trading strategies and react to changing market conditions. Throughout the case, these algorithms will submit orders to capitalize on any *statistical arbitrage* opportunities that may arise. Because of the high-frequency nature of the case, participants are encouraged to develop algorithms that can adapt to rapid changes in market dynamics.

ALGORITHMIC ETF TRADING CASE

The Algorithmic ETF Trading Case is also designed to challenge participants' programming skills in developing algorithms using MATLAB and/or Excel VBA or Python to automate trading strategies and react to changing market conditions. Throughout the case, these algorithms will submit orders to profit from *private tender offers and arbitrage* opportunities. Because of the high-frequency nature of the case, participants are encouraged to develop algorithms that can adapt to rapid changes in market dynamics.

CRUDE OIL TRADING CASE

The Crude Oil Trading Case challenges the ability of participants to trade in a closed supply and demand market for *crude oil*. Natural crude oil production and its consumption will form the framework for participants to engage in direct trade to meet each other's objectives. The case will test each participant's ability to understand sophisticated market dynamics and optimally perform his/her role, while stressing teamwork and communication. The case will involve crude oil production, refinement, storage, as well as the sale of its synthesized physical products.

NATURAL GAS TRADING CASE

The Natural Gas Trading Case tests the participants' ability to respond to the highly dynamic world of commodities trading. Participants will need to react to fundamental and geopolitical news releases and understand how the news and random demand/supply shocks will affect the price of natural gas. Participants will be encouraged to build a financial model to track and analyze the supply and demand of natural gas and trade futures contracts for different natural gas delivery months accordingly.

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Social Outcry Case

OVERVIEW

The objective of the Social Outcry Case is to allow participants to interact ("break the ice") and to recognize how financial markets have evolved technologically. The Social Outcry will be an exciting way for participants, professors and sponsors to interact with one another. Participants will be ranked based on their profits at the end of the case. Participants will trade individually and not as a team. Participants' performance in the Social Outcry Case will not count towards their final scoring of RUTC.

DESCRIPTION

Each participant will start the session with a neutral futures position. Participants are allowed to go long (buy) or go short (sell). All trades will be settled at the closing spot price.

MARKET DYNAMICS

Participants will trade futures contracts on an index, the RT100. The futures price will be determined by the market's transactions while the spot price will follow a stochastic path subject to influence from qualitative news announcements that will be displayed on a screen. News announcements will be displayed one at a time, and each news release will have an effect with uncertain direction and length (favourable news will result in an increase in the spot price, while unfavourable news will cause a decrease in the spot price; these reactions may occur instantly or with lags). Participants are expected to trade based on their interpretation of the news and on their expectations of market reactions.

TRADING LIMITS AND TRANSACTION COSTS

There are no trading commissions or fines for the Social Outcry Case. Participants are allowed to trade a maximum of 5 contracts per trade/ticket. The contract multiplier of RT100 futures is $10. There are no limits to the net position that participants can have.

RULES AND RESPONSIBILITIES

The following rules apply throughout the Social Outcry Case:

- Market agents are RUTC staff members at the front of the outcry pit collecting tickets.
- Once parties have verbally committed to a trade, they are required to transact.
- All tickets must be filled out completely and legibly, and verified by both parties. Illegible tickets will be ignored by the market agents!
- Both transacting parties are responsible for making sure that the white portion of the ticket is received by the market agent. The transaction will **not** be processed if the white portion is not submitted or is damaged. Both trading parties must walk the ticket up to the market agent for the ticket to be accepted.

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- Only the white portion of the ticket will be accepted by the market agent; trading receipts (pink and yellow portions) are for the participants' records only.
- RUTC staff reserve the right to break any unreasonable trades.
- Any breaches of the above stated rules and responsibilities are to be reported to the market agent immediately.
- All communications must be done in English.

POSITION CLOSE-OUT AND CASE SCORING

Each person's trades will be settled at the close of trading based on the final spot price. The ranking is based on the total profit and loss (P&L) from the trading session. There are no commissions or fines in the Social Outcry Case.

Example:
Throughout the trading session, one participant has made the following trades:

Buy 2 contracts @ 998
Sell 5 contracts @ 1007
Buy 1 contract @ 1004

The market closed out @ 1000. The P&L for the participant is then calculated as follows:

2 long contracts @ 998
$P\&L$: $(1000 - 998) * 2 * \$10 \ = \ \$40$

5 short contracts @ 1007
$P\&L$: $(1000 - 1007) * (-5) * \$10 \ = \ \$350$

1 long contract @ 1004
$P\&L$: $(1000 - 1004) * 1 * \$10 \ = \ -\$40$

The participant has made a total P&L of $350.

COMPLETE TRANSACTION AND OUTCRY LANGUAGE EXAMPLE

To find the market, participants simply yell "What's the market?". If someone wants to make the market on the bid side, s/he can answer "bid 50" meaning s/he wants to buy at a price ending with 50 (e.g. 950 or 1050), whichever is closest to the last price. If someone wants to make the market on the ask side, s/he will yell "at 51" meaning s/he wants to sell at a price ending with 51 (e.g. 951 or 1051), whichever is closest to the last price. Note that so far, no quantity has been declared, only two digits are required when calling the bid or ask. To complete a trade, for example, someone willing to take the ask can simply say "bought two" to the person selling. The seller's response must then be: "sold two" (or any other quantity below 2, but not 0, at the seller's discretion). After the seller and the buyer fill out the trade ticket and

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submit the white part to the ticket taker, the trade is complete. Please note that the "market maker" (participant announcing the bid or ask price) gets to decide the quantity traded up to a maximum of the quantity requested by the "market taker" (participant taking the price).

A complete transaction could run as follows:

Trader 1	"What's the market?"
Trader2	"bid 70, at 72" or "70 at 72", (bid 1070, ask 1072, this trader wants to buy and sell)
Trader3	"at 71" (the new market is 1070 to 1071)
Trader 1 to Trader 3	"Bought 5" (he/she wants to buy 5 contracts at 1071)
Trader 3 to Trader 1	"Sold 3" (Although trader 1 wanted to buy 5 contracts, trader 3 only wants to sell 3 contracts so trader 1 must accept the three contracts).
Trader 1 or Trader 3	S/he fills out the trade ticket with initials from both trader 1 and trader 3. The white portion of the ticket is submitted to the market agent by **both** traders (both traders walk the ticket up to the front of the trading floor to the market agent). Trader 1 (Buyer) keeps the yellow portion of the ticket and trader 3 (Seller) keeps the pink portion of the ticket.

There will be a brief outcry tutorial and demonstration before the Social Outcry on the first day of the competition.

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Algorithmic Statistical Arbitrage Case

OVERVIEW

The Algorithmic Statistical Arbitrage Case is designed to challenge participants' programming skills in developing algorithms using MATLAB, Excel VBA or Python to automate trading strategies and react to changing market conditions. Throughout the cases, these algorithms will submit orders to capitalize on any statistical arbitrage opportunities that may arise. Because of the high-frequency nature of the case, participants are encouraged to develop algorithms that can adapt to rapid changes in market dynamics.

DESCRIPTION

The Algorithmic Statistical Arbitrage Case will comprise of one heat with one team member from each team competing in each sub-heat. Any team member may represent the team in any one or all of the sub-heats. The heat will consist of ten 5-minute independent sub-heats representing 3 months of trading.

Parameter	Value
Number of trading heats	1
Number of trading sub-heats	10
Trading time per sub-heat	300 seconds (5 minutes)
Calendar time per sub-heat	3 months of trading

All trades must be executed by a trading algorithm, so participants will not be allowed to trade manually through the RIT Client once the sub-heat begins. However, participants are allowed to modify their Python, MATLAB, or Excel VBA algorithms between each sub-heat (allowed time: 2 minutes between each sub-heat) in response to prevailing market conditions and competition from the algorithms of other teams. A base template algorithm will be provided for participants and can be modified for use in the competition. However, participants are encouraged to create their own algorithms using Python, MATLAB, or Excel VBA. It is strongly suggested that all teams have a working version of their algorithm available on a USB or storage device.

MARKET DYNAMICS

In this case, participants will be trading three stocks from the same industry that are also included in the same index. This index is composed of 1,000 publicly traded companies. The three stocks will also be correlated with the index. Hence, there will be four securities of which the details are shown below.

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Ticker	NGN	WHEL	GEAR	RSM1000
Fee/share (Market orders)	$0.01	$0.01	$0.01	N/A
Max order size	10,000	10,000	10,000	N/A
Type	Stock	Stock	Stock	Non-tradable index

At the start of each sub-heat, historical data (representing 3 months of trading) will be made available to the participants on the RIT Client. At the beginning of each sub-heat, participants will need to calculate the historical volatilities, correlations, and other relevant statistical measures according to the formulas provided in the section "Statistical Formulas" below. These statistical measures generated from the historical values can be interpreted as the expected value of these measures.

The realized correlations in each sub-heat will be very close to the historical values. For example, if the historical correlation between stock NGN and the RSM1000 Index (calculated at the beginning of the sub-heat using the historical data) is 0.5, participants should expect that at the end of the sub-heat, the *realized* correlation between stock NGN and RSM1000 (calculated over the entire sub-heat, that is from tick 0 to tick 300) should be very close to 0.5[1].

Participants are encouraged to build an algorithm that can identify short-term deviations of the realized statistical measures from their expected values and exploit statistical arbitrage opportunities throughout the case. During the 300 ticks of trading, the market will be very liquid and participants can expect to be price takers in the market.

STATISTICAL FORMULAS

1. Rate of return on security x (at) between tick $t-1$ and t.

$$r_{x,t} = \frac{Price_{x,t}}{Price_{x,t-1}} - 1$$

2. Mean return on security x over N observations. There is 1 observation per tick and we'll refer to this mean return as "mean tick return".

$$\mu_x = \frac{\sum_{i=1}^{N} r_{x,i}}{N}$$

3. Tick Variance on security x over N observations

$$\sigma_x^2 = \frac{\sum_{i=1}^{N} (r_{x,i} - \mu_x)^2}{N-1}$$

[1] Deviations are possible due to the unpredictable behaviour of the participants' algorithms in the market.

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4. Tick Standard deviation (tick volatility) of security x over N observations

$$\sigma_x = \sqrt{\sigma_x^2}$$

5. Covariance between securities x and y over N observations

$$\sigma_{xy} = \frac{\sum_{i=1}^{N}(r_{x,i} - \mu_x)(r_{y,i} - \mu_y)}{N-1}$$

6. Correlation between securities x and y over N observations

$$\rho_{xy} = \frac{\sigma_{xy}}{\sigma_x \sigma_y}$$

7. Volatility conversion (300 ticks represent three months of trading)

$$\sigma_{annual} = \sigma_{quarterly} * \sqrt{4} = \sigma_{tick} * \sqrt{4 * 300}$$

where σ_{annual} is the annual volatility, $\sigma_{quarterly}$ is the quarterly volatility and σ_{tick} is the tick volatility.

8. Beta (β_x) calculation between a single stock (security x) and the index ($RSM1000$)

$$\beta_x = \rho_{x,RSM1000} * \frac{\sigma_x}{\sigma_{RSM1000}}$$

Where $\rho_{x,RSM1000}$ is the correlation between stock x and $RSM1000$ returns.

9. Beta (β_{Port}) for a portfolio of stocks ($Port$)(lower case P?)

$$\beta_{port} = \sum_{i=1}^{N} w_i \beta_i$$

where w_i is the weight of stock i in the portfolio.

STATISTICAL ARBITRAGE EXAMPLE

At the beginning of the sub-heat, using the historical data provided and the formulas provided in the section "Statistical Formulas", the following statistics were calculated:

Observed Historical Volatility

RSM1000	NGN	WHEL
0.0220	0.0197	0.0193

Observed Historical Correlation

	RSM1000	NGN	WHEL
RSM1000	1	0.5360	0.6462
NGN	–	1	0.3278
WHEL	–	–	1

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Historical Beta	
NGN	WHEL
0.4810	0.5659

We can calculate:

$$PTD\ Return_{i,t} = \frac{Price_{t=currrent\ tick}}{Price_{t=1}} - 1$$

where $PTD\ Return$ is the Period to Date return at time t from the beginning of the sub-heat for stock i.

$$Expected\ PTD\ Return_{i,t} = PTD\ Return_{RSM1000,t} * \beta_i$$

where $Expected\ PTD\ Return_{i,t}$ is the Expected Period to Date return at time t from the beginning for stock i, $PTD\ Return_{RSM1000,t}$ is the Period to Date return at time t from the beginning for $RSM1000$ and β_i is the $Beta$ between stock i and the index ($RSM1000$).

$$Divergence_{i,t} = PTD\ Return_{i,t} - Expected\ PTD\ Return_{i,t}$$

where $Divergence_{i,t}$ is the divergence at time t for stock i. We define the $divergence$ at time t for stock i as the difference between the realized $PTD\ Return$ and the $Expected\ PTD\ Return$ for stock i at time t.

In the table below, NGN starts to diverge after trading begins, and by tick 46, the divergence is at +8.00%. At the same time, WHEL shows a slightly positive divergence. In order to take advantage of this, one can short-sell NGN and buy WHEL in order to create a market neutral position in terms of beta (i.e. you would like the beta of the portfolio to be as close as possible to zero). Since the two stocks have different betas, $\beta_{NGN} = 0.4810$ and $\beta_{WHEL} = 0.5659$, one may decide to short $10,000 worth of NGN shares (approximately 338 shares) and buy $8,500 worth of WHEL shares (285 shares). The resulting portfolio's beta (β_{Port}) will be very close to zero since the ratio is approximately the following:

$$|(\$value\ of\ NGN\ position)/(\$\ value\ of\ WHEL\ position)| = |\beta_{WHEL} / \beta_{NGN}|$$

	Price			***PTD Return$_{i,t}$***			***Expected PTD Return$_{i,t}$***		***Divergence$_{i,t}$***	
Tick	RSM 1000	NGN	WHEL	RSM1000	NGN	WHEL	NGN	WHEL	NGN	WHEL
1	35.96	27.04	29.31	–	–	–	–	–	–	–
…	…	…	…	…	…	…	…	…	…	…
46	36.78	29.50	29.77	0.0228	0.0910	0.0157	0.0110	0.0129	0.080	0.0028
…	…	…	…	…	…	…	…	…	…	…
59	36.18	26.84	29.36	0.0061	-0.0074	0.0017	0.0029	0.0035	-0.0103	-0.0018

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When the divergence converges towards zero at tick 59, one can close the position, and the realized profits from the statistical arbitrage will be equal to the arbitrage spread minus commissions:

$$(\$29.50 - \$26.84) * 338 + (\$29.36 - \$29.77) * 285 - (338 + 285) * \$0.01 * 2 = \$769.77$$

TRADING LIMITS AND TRANSACTION COSTS

Time of Sub-heat (tick)	Gross/Net
1 ~ 299	500,000/100,000
300	0/0

Each trader will be subject to gross and net trading limits during trading in each sub-heat. The gross trading limit reflects the sum of the absolute values of the long and short positions across all securities and the net trading limit reflects the sum of long and short positions such that short positions negate any long positions. Trading limits will be strictly enforced and participants will not be able to exceed them. Each position in stock will be counted towards trading limits with a multiplier of 1 (i.e. if you long 100 shares of any stocks, your gross and the net trading limits will increase by 100).

The maximum trade size will be 10,000 shares per order for stocks. Transaction fees will be set at $0.01 per share for stocks on all market and limit orders filled.

POSITION CLOSE-OUT

Any non-zero position will be closed out at the end of trading at either the last traded price or the correct price if the stock is experiencing a divergence due to market shock. As such, participants are not required to close statistical arbitrage positions as the sub-heat ends.

KEY OBJECTIVES

Objective 1

Create a model using the provided template to calculate relevant statistical measures between the 3 stocks and non-tradable index.

Objective 2

Build a trading algorithm and optimize the trading parameters such that the algorithm efficiently takes advantage of statistical arbitrage opportunities while managing risk exposure and order flow.

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Algorithmic ETF Trading Case

OVERVIEW

The Algorithmic ETF Trading Case is also designed to challenge participants' programming skills in developing algorithms using MATLAB, Excel VBA, or Python to automate trading strategies and react to changing market conditions. Throughout the case, these algorithms will submit orders to profit from private tender offers and arbitrage opportunities. Because of the high-frequency nature of the case, participants are encouraged to develop algorithms that can adapt to rapid changes in market dynamics.

DESCRIPTION

The Algorithmic ETF Trading Case will comprise of one heat with one team member from each team competing in each sub-heat. Any team member may represent the team in any one or all of the sub-heats. The heat will consist of ten 5-minute independent sub-heats representing 3 months of trading.

Parameter	Value
Number of trading heats	1
Number of trading sub-heats	10
Trading time per sub-heat	300 seconds (5 minutes)
Calendar time per sub-heat	3 months of trading

All trades must be executed by a trading algorithm. Participants will not be allowed to trade manually through the RIT Client once the sub-heat begins (but they will be allowed to manually use the RIT Client to use Converters – see Market Dynamics section below). However, participants are allowed to use and modify their Python, MATLAB, or Excel VBA algorithms in between sub-heats (time allowed: 2 minutes between each sub-heat) in response to prevailing market conditions and competition from the algorithms of other teams. A base template algorithm will be provided for participants and can be directly modified for use in the competition. However, participants are encouraged to create their own algorithms using Python, MATLAB, or Excel VBA. It is strongly suggested that all teams have a working version of their algorithm available on a USB or storage device.

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MARKET DYNAMICS

This case involves five securities with the following details.

Ticker	CAD	USD	BULL	BEAR	RUTC
Security type	Currency	Currency	Stock	Stock	ETF
Quote currency	CAD	CAD	CAD	CAD	USD
Starting Price	n/a	n/a	$10	$15	$25
Fee/share (Market orders)	n/a	n/a	$0.02	$0.02	$0.02
Rebate/share (Limit/Passive orders)	n/a	n/a	$0.01	$0.01	$0.01
Max order size	2,500,000	2,500,000	5,000	5,000	10,000

The base currency in this case will be CAD. Therefore, USD will be quoted in a direct exchange rate as the number of CAD required to buy 1 USD.

Participants will be able to trade two stocks denominated in CAD and one ETF denominated in USD with varying levels of volatility and liquidity. This dynamic exposes participants to the basics of market microstructure in the context of algorithmic trading. In equilibrium, the ETF pricing will reflect the following sum of the two traded stocks, subject to periodic shocks to its price.

$$RUTC_{USD} * USD = BULL_{CAD} + BEAR_{CAD}$$

Participants will also receive private tender offers for the ETF on the RIT Client. Since the decision time for the ETF is very short, participants should build an algorithm to evaluate the profitability of a tender offer to make a decision to accept it or not. Once a tender offer is accepted, a participant's algorithm should also unwind the positions at a profit while managing the market price impact of trades.

In addition, there will be two converters[2] available to facilitate a conversion between the underlying stocks and the ETF: ETF-Creation and ETF-Redemption Converters. Participants should consider using these converters as an alternative approach to manage the liquidity risk associated with submitting orders directly to the market. Please note that these converters can only be used by human traders: you will be allowed and able to use them from the RIT Client manually during trading, but your algorithm will not be able to use them automatically through the API.

[2] The two converters are available from the "Assets" tab from RIT Client.

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Converters	Description	Convert From	Convert To	Cost
ETF-Creation	ETF creation from underlying stocks	10,000 BULL stocks and 10,000 BEAR stocks	10,000 units of RUTC	$1,500 USD/use
ETF-Redemption	ETF redemption to underlying stocks	10,000 units of RUTC	10,000 BULL stocks and 10,000 BEAR stocks	$1,500 USD/use

TRADING/POSITION LIMITS AND TRANSACTION COSTS

Each trader will be subject to gross and net trading/position limits during trading in each sub-heat. The gross limit reflects the sum of the absolute values of the long and short positions across all securities, and the net limit reflects the sum of long and short positions such that short positions negate any long positions. Trading/position limits will be strictly enforced and participants will not be able to exceed them. Each position in the stocks will be counted towards trading/position limits with a multiplier of one, while each position in the ETF will be counted with a multiplier of two (i.e. if you long 100 shares of any stocks, your gross and net limits will increase by 100. If you long 100 positions of RUTC, your gross and net limits will increase by 200 (100 positions * multiplier of two)).

The maximum trade size will be 5,000 shares per order for stocks and 10,000 shares per order for the ETF. Transaction fees will be set at $0.02 per share for each stock and the ETF on all market orders filled. Subsequently, a rebate of $0.01 per share for each stock and the ETF will be provided for all submitted limit orders that are filled.

POSITION CLOSE-OUT

Any non-zero position of stocks will be closed out at the end of trading based on the last traded price while the ETF will be closed out at the fair value of the sum of both stocks converted to CAD.

KEY OBJECTIVES

Objective 1

Create a model using the provided template to identify the profitability of private tender offers and execute trades accordingly while managing liquidity risk and market risk. Consider utilizing the ETF-Creation and ETF-Redemption Converters provided on the RIT Client as an alternative approach to mitigate the liquidity risk when working a private tender offer.

Objective 2

Build a trading algorithm that identifies arbitrage opportunities between underlying stocks and the ETF. Consider trading CAD and USD in order to hedge the currency exchange rate exposure.

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Crude Oil Trading Case

OVERVIEW

The Crude Oil Trading Case challenges the ability of participants to trade in a closed supply and demand market for crude oil. Natural crude oil production and its consumption will form the framework for participants to engage in direct trade to meet each other's objectives. The case will test each participant's ability to understand sophisticated market dynamics and optimally perform his/her role, while stressing teamwork and communication. The case will involve crude oil production, refinement, storage, as well as the sale of its synthesized physical products.

DESCRIPTION

The Crude Oil Trading Case will comprise of one heat with 3 team members competing together. The heat will consist of four 16-minute independent sub-heats, each representing two months, or 40 trading days. Each sub-heat will involve six tradable securities and five assets. Order submission using the RIT API will be disabled. Data retrieval via Real time data (RTD) links and the RIT API will be enabled.

Parameter	Value
Number of trading sub-heats	4
Trading time per sub-heat	16 minutes (960 seconds)
Calendar time per sub-heat	2 months (40 trading days)
Maximum order size	5 contracts
Mark-to-market frequency	Daily (24 seconds)

TEAM ROLES

In this case, each team member will have 1 of 3 specific roles:

1. Producer
2. Refiner
3. Trader

Each team will have 1 producer, 1 refiner, and 1 trader. The team will determine the role of each member.

Example:

The team ROTMAN will have 3 trader-IDs (ROTMAN-1, ROTMAN-2, ROTMAN-3), and roles have been assigned according to the list below.

Trader-ID	Role
ROTMAN-1	Producer
ROTMAN-2	Refiner
ROTMAN-3	Trader

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Please remember to submit each member's role in the team schedule by **Friday, July 26th** as specified in the "Important Information" section above. If a team misses this deadline, the roles will be randomly assigned by competition staff.

Producer

The producer owns oil rigs that produce both Light and Heavy Crude Oil and also owns storage facilities for each type of oil. The average production of each type of Crude Oil is about 2,000 barrels per day, or 10,000 barrels per week (excluding weekends). Oil is produced at a base cost of $35/barrel for Light Crude Oil and $30/barrel for Heavy Crude Oil. Production costs and quantities for both Light and Heavy Crude Oil can fluctuate because of external factors. The producer can expect to receive all of his/her weekly production of Light and Heavy Crude Oil at the beginning of each week, but there may be unexpected delays in the delivery to the storage facility. Producers will receive news detailing delivery delays, production quantity variance, and production cost shocks.

Producers start with an initial endowment of both types of Crude Oil and will have a total storage capacity of 20,000 barrels for Light Crude Oil and 20,000 barrels for Heavy Crude Oil. It is important to note that producers cannot mix Light and Heavy Oil in their storage tanks: each storage tank can only be used for the specified type of Crude Oil. Additionally, a producer cannot shut down the production of any of his/her oil rigs. In the event that a producer exceeds the storage limit, he or she will be forced to lease additional storage for the remainder of the simulation at an expensive distressed storage cost. Distressed storage costs are the same for both Heavy and Light Crude Oil storage tanks; however, since the two types of Crude Oil are stored separately, distressed storage costs are applied independently.

Refiner

Each refiner has access to three separate facilities: a refinery that refines only Light Crude Oil, a refinery that refines only Heavy Crude Oil, and one that refines both Light and Heavy Crude Oil simultaneously. For every 5 barrels of Light Crude Oil, the Light Refinery (L-Refinery) will produce 3 barrels of RBOB Gasoline and 2 barrels of Heating Oil (5-3-2) at a production cost of $25/barrel. For every 5 barrels of Heavy Crude Oil, the Heavy Refinery (H-Refinery) will produce 2 barrels of RBOB Gasoline and 3 barrels of Heating Oil (5-2-3) at a production cost of $35/barrel. For every 1 barrel of Light Crude Oil and 1 barrel of Heavy Crude Oil, the Light and Heavy Refinery (L/H Refinery) will produce 1 barrel of RBOB Gasoline and 1 barrel of Heating Oil (2-1-1) at a production cost of $30/barrel. RBOB Gasoline and Heating Oil are traded in gallons, where **one barrel equals 42 gallons**. All three refineries will have a refining time of 108 seconds and a refinery lease time of 120 seconds. However, the lease function will be disabled when the remaining time in the sub-heat is less than 108 seconds.

Refiners will receive news impacting the prices of RBOB Gasoline and Heating Oil in the future, and will have to evaluate the impacts of these news items in order to decide which refinery, if any, is profitable to operate.

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The RBOB Gasoline price will be mainly affected by news items related to market demand. These news items will need to be evaluated by refiners in order to determine their impact and how the future RBOB Gasoline price will change.

The primary driver of Heating Oil prices will be fluctuations in temperature, since demand for Heating Oil will increase as expected temperatures fall. Hence, the price impact of changes in temperature will be estimated based on the simplified equation below:

$$P_{HO} = E_{HO} + \frac{\Delta_{HO}}{\sigma_{HO}}$$

Where,

P_{HO} is the final close out price for Heating Oil;
E_{HO} is the expected price for Heating Oil;
Δ_{HO} is the expected weekly temperature change;
σ_{HO} is the standard deviation of the temperature change.

$$Expected\ weekly\ temperature\ change = Expected\ weekly\ temperature - Realized\ weekly\ temperature$$

The expected price for Heating Oil will start at $2.50/gallon. Information regarding the weather will be released on a weekly basis through news items. Furthermore, it is possible for Heating Oil prices to be affected by external shocks affecting market demand and supply. These external shocks must be evaluated by refiners in order to determine their impact and estimate future Heating Oil prices.

Refiners will need to accurately determine the profitability of running their refineries by evaluating the prices of their inputs (Light and/or Heavy Crude Oil) as well as their future outputs (Heating Oil and RBOB Gasoline).

Refiners start with an initial endowment of 5,000 barrels of Light Crude Oil and 5,000 barrels of Heavy Crude Oil and will have a total storage capacity of 20,000 barrels for each oil type. Heating Oil and RBOB Gasoline do not require storage.

Traders

Traders have access to Light and Heavy Crude Oil markets as well as Heating Oil and RBOB Gasoline futures markets. During the trading period, traders will receive institutional orders from overseas clients who wish to buy or sell Light and Heavy Crude Oil. Traders act as the "shock absorber" for the market. They balance the supply and demand, and help markets achieve equilibrium by naturally filling up their storage tanks when crude prices are very low and by selling them back to the market when prices are relatively high for each type of Crude Oil.

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MARKET DYNAMICS

Producers, Traders, and Refiners will be able to trade the securities according to the table below.

Commodities

Securities	Description	Contract Size	Accessibility	Shortable
CL-L	Light Crude Oil Spot	1,000 Barrels	Producer, Refiner, Trader	No
CL-H	Heavy Crude Oil Spot	1,000 Barrels	Producer, Refiner, Trader	No
HO-2F	Month 2 futures contract for HO	42,000 Gallons	Trader	Yes
RB-2F	Month 2 futures contract for RB	42,000 Gallons	Trader	Yes
RB	RBOB Gasoline	42,000 Gallons	Refiner	No
HO	Heating Oil	42,000 Gallons	Refiner	No

Participants will be able to utilize the following assets, which are required for storing and refining physical crude products.

Assets	Description	Capacity (Barrels)	Cost	Conversion Period
CL-L STORAGE	Storage for Light Crude Oil	10,000	Free*	N/A
CL-H STORAGE	Storage for Heavy Crude Oil	10,000	Free*	N/A
L-Refinery	Refinery Designed to Process Light Crude Oil Only	10,000	$250,000 per 5 trading days	4.5 trading days
H-Refinery	Refinery Designed to Process Heavy Crude Oil Only	10,000	$350,000 per 5 trading days	4.5 trading days
L/H-Refinery	Refinery Designed to Process a Combination of Light and Heavy Crude Oil	10,000	$300,000 per 5 trading days	4.5 trading days

*All starting endowments of storage are free. Subsequent storage leased (due to overproduction) will be charged at a lease price of $500,000 per storage unit, which can hold up to 10,000 barrels.

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Industry-specific news will be released to participants based on their roles. Producers will receive expected production reports of their oil rigs (which are subject to changes throughout the simulation). Actual production may be different from the forecast, in which case producers will be informed of the quantity shock in the next expected production report. Producers will also be subject to shocks influencing the production price of crude and the time at which production is delivered. Refiners will receive information on the downstream RBOB Gasoline and Heating Oil markets, and they must use this information to forecast future prices. Traders will receive "The International Tender Report" which describes the expected institutional orders activity.

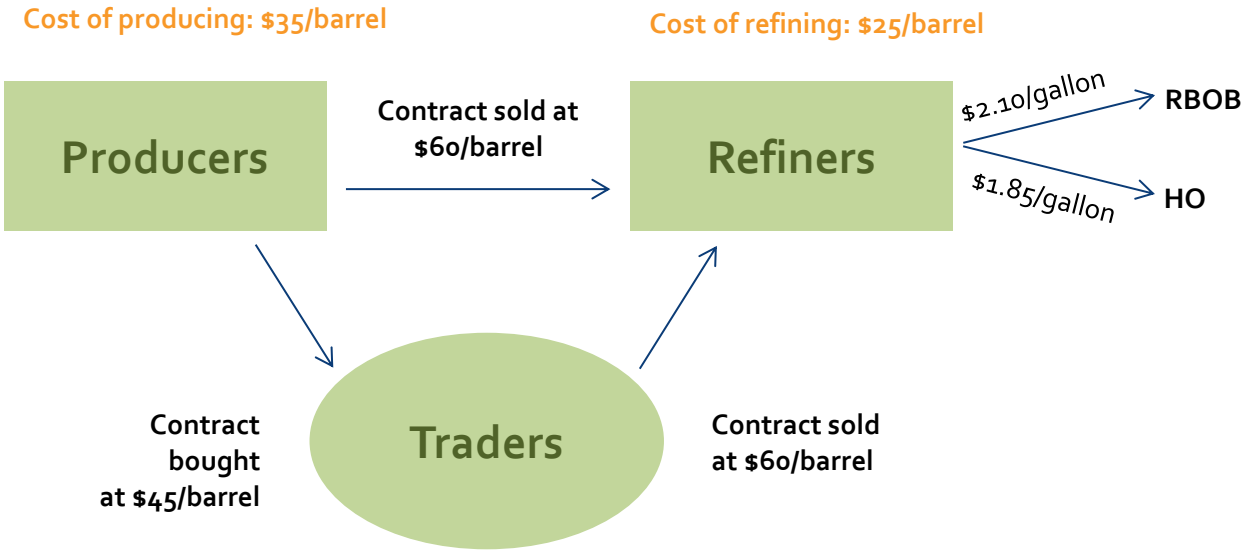
The interaction between different market participants (producer, refiner, and traders) within each team, including their profit maximization objectives, is what will largely influence the overall profits of each team. Therefore, participants should optimize the dynamics of each role.

The following is a simplified example of the case:

Assume that RBOB and HO are currently trading at $2.10/gallon and $1.85/gallon respectively. Those outputs can be obtained using the Light Refinery, giving a Light Crude refined value of $2.00/gallon. If you convert this value into barrels: 42,000 * $2/gallon = $84,000 per 1,000 barrels, or $84/barrel. Refiners have bought ten contracts, agreeing to buy 5,000 barrels of Light Crude Oil from the producers and 5,000 barrels of Light Crude Oil from traders at a price of $60/barrel. In this scenario, refiners choose to operate only the Light Refinery. Traders initially bought Light Crude from producers at a spot price of $45/barrel.

Profit generated by each team member (per barrel):

- Producers: Price per contract - cost of producing oil per barrel = $60 - $35 = $25
- Refiners: Value of refined oil - cost of buying and refining oil = $84.00 - ($60 + $25) = -$1.00
- Traders: Price of contract sold - spot price of oil bought = $60 - $45 = $15



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TRADING/POSITION LIMITS AND TRANSACTION COSTS

Each participant will be subject to trading/position limits. Separate limits will be maintained for Light and Heavy Crude Oil (CRUDE) and RBOB/HO Products (PRODUCT). Trading limits will be strictly enforced and participants will not be able to exceed them by trading. However, production and refining assets can and will cause limit breaches if they are not managed properly, resulting in a penalty of $25,000 per contract over each gross and net limit.

The maximum trade size will be 5 contracts, restricting the volume of the contracts transacted per trade to 5.

POSITION CLOSE OUT

All futures positions will be marked-to-market every 24 seconds with any profits and losses reflected in the traders' cash balance by the mark-to-market operation.

Each security position, except Light and Heavy Crude Oil, will be closed out at the last traded price. Light Crude Oil will be closed out at $50/barrel and Heavy Crude Oil will be closed at $40/barrel regardless of the market price.

KEY OBJECTIVES

Objective 1

Design a model to calculate the effect of news releases on the prices of Crude Oil, Heating Oil and RBOB Gasoline. Using information gathered from news releases and trading data, track the supply and demand of oil throughout the simulation to determine optimal storage usage and trading strategies.

Objective 2

Maximize profits as a team of producers, refiners, and traders by communicating private news information with each other.

Note: Since this simulation requires a large number of participants in order to establish supply/demand, practice sessions for this case will be organized and held at specified times - please refer to the "Important Information" section above. After organized practice sessions are completed, cases will be run iteratively for model calibration purposes ("trading skillfully" cannot be practiced unless there are 20+ users online).

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Natural Gas Trading Case

OVERVIEW

The Natural Gas Trading Case tests the participants' ability to respond to the highly dynamic world of commodities trading. Participants will need to react to fundamental and geopolitical news releases and understand how the news and random demand/supply shocks will affect the price of natural gas. Participants will be encouraged to build a financial model to track and analyze the supply and demand of natural gas and trade futures contracts for different natural gas delivery months accordingly.

DESCRIPTION

The Natural Gas Trading Case will comprise of 3 sub-heats. Each sub-heat will be independent from the others and will consist of 3 periods, each of 10 minutes of trading representing 1 month of trading. Order submission using the RIT API will be disabled. Data retrieval via Real time data (RTD) links and the RIT API will be enabled.

Parameter	Value
Number of trading sub-heats	3
Trading time per sub-heat	30 minutes (1800 seconds)
Number of trading periods per sub-heat	3
Trading time per period	10 minutes (600 seconds)
Calendar time per sub-heat	3 months
Calendar time per period	1 month
Compounding interval	1 day (30 seconds)

MARKET DYNAMICS

There are 3 tradable futures contracts. Each futures contract represents 4000 mmBtu's of natural gas settled/delivered at the end of July, August, or September. All contracts will be marked to market every 30 seconds based on the last traded price. Contracts will settle at the end of their respective months based on the calculated market price (explained below). There is a maximum order size of 25 futures contracts in a single order.

The key drivers of the value of natural gas contracts are the supply and usage of natural gas for a given month. The important factor is the difference between natural gas supplied and used, which is the amount stored (or drawn from storage). When we compare the difference between the amounts that we expect to store versus the amount that we actually store, we get a storage shortfall (a negative storage shortfall would be excess storage). July, August, and September are considered storage months because more natural gas is supplied than is used, therefore underground storage tanks can be filled for the heavy-demand of the winter months. This case takes place at the end of the summer. Warmer temperatures cause more air conditioning use

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which causes more electricity usage. This in turn causes more natural gas to be burned to create electricity. This ultimately means warmer temperatures mean more electricity usage.

The price dynamics in this case are based on the amount of natural gas in storage at the end of the contract month. Based on historical data, the market is expecting the following amounts of natural gas to be supplied, used and stored for each month (data in Billions of Cubic Feet (BCF)).

	July	August	September
Expected NG Supply	2000	1980	1940
Expected NG Usage	1760	1620	1520
Expected NG Stored	240	360	420
Expected NG in Storage (at the end of the month)	6840	7200	7620
Actual NG Supply	To be released on RIT during the trading case		
Actual NG Usage			
Actual NG Stored			
Actual NG in Storage			
Storage Shortfall/Excess			
Standard Deviation	90	70	60
Expected Price	$6.00	$5.80	$6.00

*There is 6600 NG in storage on June 30th.

Note: BCF/mmBtu conversion ratios have no relevance in this case, as BCF is simply the way supply/usage/storage is expressed, while mmBtu's are the units of trade.

Actual values are released on a weekly basis - that is, every 2.5 minutes the actual data for Week 1 (2, 3, 4) is released. The actual data shows the amount of natural gas supplied, used, and stored.

There is no intra-month seasonality. That is, if the month's expected supply is 2000 BCF, you can assume that means that 500 BCF is supplied per week. However, shocks may cause individual weeks to deviate.

The final closing price of a natural gas contract for a given month is based on the expected price and the monthly storage excess/shortfall. The final closing price is calculated starting with the expected price, and then adding (subtracting) $1 for every one standard deviation of storage shortfall (excess). This can be expressed mathematically as:

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$$P_m = E_m + \frac{\mu_m}{\sigma_m}$$

$$Where;\ P_m\ is\ the\ final\ close\ out\ price\ ,E_m\ is\ the\ expected\ price,$$
$$\mu_m\ is\ the\ storage\ shortfall, \sigma_m\ is\ the\ standard\ deviation\ for\ month\ m$$

It states that the final price of the natural gas contract is equal to the expected price (given in the table above), plus the storage shortfall (forecast and then it is eventually revealed) divided by the standard deviation of the shortfall (also given in the table above).

Temperatures will generally cause BCF fluctuations between -12 and 12 additional BCF per region. A reading of 12 would be caused by extremely warm conditions (compared to usual) and -12 would be caused by extremely cold conditions (compared to usual).

It is important to note that storage shortfalls and surpluses persist and are cumulative. A shortfall (or surplus) in July implies a shortfall (or surplus) in August and September, if all other factors remain the same. The reason is that a supply/usage shock to a single month will also affect all other months – although the amount of the effect will be different because the sensitivity to the natural gas shortfall (or surplus) for each month (standard deviation) is different.

Examples:

If no news happens in an entire month of July, the expected amount of supply for July is realized, the expected usage is realized too, the result is that the expected amount of gas goes into storage. There is no storage shortfall. Therefore the final closing price of the July contract is $6 (i.e. $6 + 0/90). Nothing happened to change the supply or usage of natural gas in July.

If instead, at the end of July, 1985 BCF of NG were supplied (e.g. a natural gas pipeline had to shut down for maintenance, causing natural gas producers to decrease supply by 25 BCF), and 1770 BCF were used. As a result, 215 BCF went into storage. At the end of the month, actual storage was 6815. The shortfall was 25 BCF. The final closing price of the July contract is $6.28 (i.e. $6 + 25/90 = $6.277).

To continue with this example, assuming that no other information (future supply/usage forecasts, weather etc.) were available, at the end of July we should assume that August and September supply, usage and storage values will be as expected. However, overall storage in each month will be lower because of the shortfall in July. We could forecast that the August contract's closing price will be $6.15 (i.e. $5.80 + 25/70), and September's closing price will be $6.42 (i.e. $6.00 + 25/60).

The weekly data will help traders refine their estimates for the month's supply and usage. For example, the base scenario for July is 500 BCF per week. If after week 1, the data is released and 525 BCF were supplied, we can assume, without any other data, that the month's supply will probably be around 2025 BCF (assume that each following month will be as expected, unless there is news to indicate otherwise.) We can do the same for the usage and storage results. One way to think about it is as follows:

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After week 1 release:

	Expected Supply	Expected Usage	Actual Supply	Actual Usage
Week 1	500	440	525	440
Week 2	500	440	A	D
Week 3	500	440	B	E
Week 4	500	440	C	F
July	2000	1760	525 + A + B + C	440 + A + B + C

Traders will be periodically given information which allows them to model future natural gas data so that they can forecast future prices. Traders are expected to use these news releases with their simple pricing model to compute expected settlement prices for each month's contract. Traders can then compare their computed estimates with the market prices and generate profits by capturing perceived discrepancies between the actual value and market value of natural gas.

The July supply is actually made up of 4 variables: each week's supply. Likewise, the July usage is made up of 4 variables: each week's usage. As time passes and these figures are released, fewer variables are used to calculate the total month's supply & usage. Week 4's values are reported prior to the end of trading so there is a brief time when traders will know the exact settlement price and still be able to trade.

INFORMATION RELEASE SCHEDULE

There are three types of news releases provided to traders: weekly weather reports, weekly Department of Energy (DOE) data, and random news events. Each month, the news is released according to the following schedule:

Release	Release Time (Seconds Elapsed)
1st Week Weather Report	60
1st Week DOE Data	120
2nd Week Weather Report	210
2nd Week DOE Data	270
3rd Week Weather Report	360
3rd Week DOE Data	420
4th Week Weather Report	510
4th Week DOE Data	570
Random News Events	Random

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Sample News Releases:

Weekly Weather Report and Long Term Forecast

The Weather Network (TWN) released average weather conditions for the different districts in North America as well as forecasts for next week.

Current Weather Conditions

District	Estimated BCF Variation
North	1
East	8
South	-4
West	1

*Estimated BCF variation implies how many additional BCF are expected to be used because of the temperature. Positive numbers represent more usage, negative numbers represent less usage.

Week-Ahead Weather Forecast

District	Forecast Temperature vs. Average
North	Average
East	Average
South	Cooler
West	Average

Weekly DOE Report

Wk #1 July

Department of Energy Weekly Supply Data : 500 BCF

Department of Energy Weekly Usage Data : 444 BCF

Department of Energy Weekly Storage Data : 56 BCF

Headline News – Example 1

A small natural gas pipeline exploded injuring two workers today. The pipeline capacity is 10 BCF/day and as currently been shut down. Officials have not released an estimate as to when the pipeline will be back up.

Headline News – Example 2

CarryGas Inc. today announced that they have launched 3 Liquefied Natural Gas (LNG) supertankers carrying 18 BCF of natural gas from Europe. The ships are expected to come to port in the second week of August. This marks the first trans-Atlantic LNG shipment ever.

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TRADING LIMITS AND TRANSACTION COSTS

Each participant will be subject to gross and net trading/position limits. The gross limit reflects the sum of the absolute values of the long and short positions across all securities, while the net limit reflects the sum of long and short positions such that short positions negate any long positions. Trading/position limits will be strictly enforced and participants will not be able to exceed them.

A commission of $5 dollars per futures contract is charged for every transaction. The maximum order size will be 25 contracts per order.

POSITION CLOSE OUT

Futures positions that remain open at the end of each period will be marked-to-market at the last traded price. If the end of the period is also the expiration of the contract, the contract will be marked-to-market at the final fair value which will be calculated based on the NG storage shortfall/excess.

KEY OBJECTIVES

Objective 1:

Build a financial model to track and analyze fundamental and geopolitical news items and determine how they will affect the level of supply and demand of natural gas. Based on the analysis, participants should be able to identify and exploit profit opportunities.

Objective 2:

Manage exposure to market risk. Participants may consider implementing calendar spread trades in order to generate profits from the price differential between the two contracts while hedge against market risk.

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